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(54) SOLID-STAGE IMAGE PICKUP DEVICE

(57)Abstract:
PURPOSE: To provide a solid-state image pickup device where the degree of freedom in designing a microlens is high even if the picture elements are micronized, and which can have an good microlens effect.
CONSTITUTION: A hole 10 of light waveguide path is made by etching an insulating film 6, for the MOS photodiode consisting of a channel region 3 of a CMD, a gate oxide film 4, and a gate electrode 5, and then an insulating film 11 and a metallic film 12 are formed in order. The metallic film 12 is removed by a RIE method, and then a light waveguide path 10a is made by filling the hole 10 with transparent material such as SiO2 or the like, leaving the metallic film 12 only at the sidewall of the hole 10, and also a flattening layer 13 and a microlens 14 are so formed that the focus exists on the incident face of the light waveguide path 10a or in its vicinity, thus a solid-state image pickup device fitted with a microlens constituted.

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CLAIMS

[Claim(s)]
[Claim 1] The solid state camera characterized by constituting so that a micro lens on chip may be formed in the upper part of this optical waveguide and the focus of this micro lens on chip may exist near [optical plane-of-incidence] said optical waveguide at least in the solid state camera which has the light sensing portion which has arranged many pixels containing photo diode in the shape of two-dimensional, and an insulating layer including wiring formed on this light sensing portion while preparing optical waveguide vertically to the light-receiving side of a light sensing portion in a part of insulating layer on said photo diode.
[Claim 2] Said optical waveguide is a solid state camera according to claim 1 characterized by covering the side attachment wall with the thin film which has a rate of a high light reflex.
[Claim 3] The thin film which has said Takamitsu reflection factor is a solid state camera according to claim 2 characterized by being formed with aluminum, silver, or gold.
[Claim 4] The solid state camera according to claim 2 or 3 characterized by forming the thin film which consists of an insulating material between the thin film which has the Takamitsu reflection factor prepared in the side attachment wall of said optical waveguide, and the insulating layer which has said wiring.
[Claim 5] Said optical waveguide is a solid state camera according to claim 1 characterized by being formed with the ingredient with a larger refractive index than the refractive index of said insulating layer surrounding this optical waveguide.
[Claim 6] The ingredient with the large refractive index which forms said optical waveguide is a solid state camera according to claim 5 characterized by being titanium oxide.
[Claim 7] A solid state camera given in any 1 term of claims 1-6 characterized by facing the optical outgoing radiation side side of said optical waveguide, and forming the silicon nitride film.
[Claim 8] A solid state camera given in any 1 term of claims 1-7 characterized by constituting so that the area by the side of the optical plane of incidence of said optical waveguide may consist of area by the side of an optical outgoing radiation side size.
[Claim 9] A solid state camera given in any 1 term of claims 1-8 characterized by forming in fields other than the optical waveguide part by the side of the optical plane of incidence of said optical waveguide the film which has absorption or a low reflection property to light.
[Claim 10] The film which has absorption or a low reflection property to said light is a solid state camera according to claim 9 characterized by being titanium or the titanium

night RAIDO film.
[Claim 11] Said optical waveguide is a solid state camera given in any 1 term of claims 1, 2, 3, 4, 7, 8, 9, and 10 characterized by being formed with the light filter.
[Claim 12] The solid state camera according to claim 11 characterized by forming the thin film which consists of an insulating material between said light filter and the thin film which has said Takamitsu reflection factor.
[Claim 13] Said optical waveguide is a solid state camera given in any 1 term of claims 1, 2, 3, 4, 7, 8, 9, and 10 characterized by being formed with the fluorescent material which has the operation which changes blue glow into green light or red light.
[Claim 14] The solid state camera according to claim 13 characterized by forming the thin film which consists of an insulating material between said fluorescent material and the thin film which has said Takamitsu reflection factor.
[Claim 15] A solid state camera given in any 1 term of claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, and 14 characterized by preparing the light filter between the optical plane-of-incidence side of said optical waveguide, and said micro lens on chip.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the solid state camera which prepared the micro lens in order to raise sensibility.
[0002]
[Description of the Prior Art] In recent years, in order to raise sensibility in a solid state camera, on a light sensing portion photodiode, on chip one or a lamination technique is used, a micro lens is formed, and improvement in a numerical aperture is measured. About this technique, what was applied to INTARAIN transfer CCD image pick-up equipment is shown, for example in JP,60-38989,A.
[0003] Next, the technical content currently indicated by the above-mentioned official report is explained. First, drawing 8 is the flat-surface conceptual diagram of INTARAIN transfer CCD image pick-up equipment, and is 101. For example, the optoelectric transducer which consists of a photodiode and 102 Optoelectric transducer 101 Although it is the vertical CCD register which reads the signal which carried out photo electric translation and not being illustrated, they are a photodiode and the vertical CCD register 102. In between, the transfer gate field which controls a transfer of a signal charge is arranged. 103 ** -- vertical CCD register 102 transmitted in parallel a signal -- every line -- the output section 104 It is the level CCD register to read. Drawing 9 is the enlarged drawing of drawing 8 , and is 101. An optoelectric transducer and 102 A vertical CCD register and 105 A transfer gate field, 106, and 107 Vertical CCD register 102 It is a transfer electrode and polycrystalline silicon is usually used. The transfer electrode 106 and 107 One optoelectric transducer 101 Although it corresponds, and 1/2 step of CCD is formed and not being illustrated, each transfer electrode is the vertical CCD register 102. In the part, impurity control of two-layer gate structure or a substrate semi-conductor is performed so that it may have two different potentials. Moreover, the transfer electrode

106 and 107 Optoelectric transducer 101 Vertical separation section 108 It lets it pass and connects with the adjoining vertical CCD register. Moreover, transfer gate field 105 And vertical CCD register 102 For example, layer 109 which does not let light like aluminum pass It is shaded. Thus, it sets to the CCD image pick-up equipment constituted, and is an optoelectric transducer 101. The actual numerical aperture is restricted to 20 - 40%.
[0004] Next, the formation approach of a micro lens established in order to raise the numerical aperture in this CCD image pick-up equipment currently indicated by the above-mentioned official report is explained. Drawing 10 shows typically the cross section which met the A-A' line of drawing 9 . INTARAIN transfer CCD image pick-up equipment is the semi-conductor substrate 100. Vertical CCD register 102 which becomes a principal plane from the transfer gate field 105 controlled by the impurity, and an embedding channel about the optoelectric transducers 101, such as a photodiode with the conductivity type of a substrate impurity and objection, and threshold voltage It is formed. And in the front face of a substrate, it is an insulator layer 110. It minds and is the transfer electrode 106. It is arranged. Furthermore, phosphorus glass layer 111 It minds and is the vertical CCD register 102. And transfer gate field 105 Protection-from-light layer 109 which consists of aluminum so that it may shade It is arranged.
[0005] 1st resin layer 112 which is transparent to the principal plane of CCD image pick-up equipment, and has photosensitivity in it as first shown in drawing 11 in order to form the lens for the improvement in a numerical aperture in the INTARAIN transfer CCD image pick-up equipment of such a configuration It forms. This photopolymer layer 112 While losing the irregularity of the principal plane of CCD image pick-up equipment, it serves as the duty which adjusts the focal distance of a lens so that the focus of the lens formed later may connect on an optoelectric transducer. The thickness of the transparence photopolymer layer 112 is the curvature of a lens, the refractive index of a lens ingredient, and an optoelectric transducer 101. It is determined by the numerical aperture. this example of a configuration -- like -- photopolymer layer 112 the case where it is used as a condenser lens -- a refractive index -- the radius of curvature of 1.5 and a lens -- optoelectric transducer 101 A pitch and optoelectric transducer 101 if it is 50% of numerical apertures -- at least -- photopolymer layer 112 thickness -- optoelectric transducer 101 1/of a pitch -- it is needed two or more.
[0006] Photopolymer layer 112 The bonding pad section of image pick-up equipment and the photopolymer layer 112 on a SUKURAIPU line after covering It removes using a photoresist operation of resin itself. After that photopolymer layer 112 In order to harden, it is this resin layer 112. It heat-treats above inversion temperature. Next, photopolymer layer 112 2nd photopolymer layer 113 for forming a lens array upwards It covers. Then, 2nd photopolymer layer 113 It is the protection-from-light layer 109 by the photoresist process of exposure and development. The upper part and the upper optoelectric transducer 101 The vertical separation section 108 separated perpendicularly The upper part is removed. Drawing 12 is the 2nd photopolymer layer 113. It is a mimetic diagram after development and is this 2nd photopolymer layer 113. Optoelectric transducer 101 It corresponds and is formed in the shape of a mosaic. In addition, drawing 13 is drawing showing the cross section of drawing 12.
[0007] Then, the 2nd photopolymer layer 113 It is beyond the inversion temperature of resin, and is the 1st photopolymer layer 112. It heat-treats on conditions lower than the heat-treated temperature, and is this resin layer 113. It is fabricated by the lens

configuration by heat floating, and is the micro-lens array section 114. It is formed. Drawing 14 is the 2nd photopolymer layer 113. It is a sectional view after heat treatment.
[0008] thus, the micro-lens array section 114 the formed CCD image pick-up equipment -- setting -- incident light -- the lens-like 2nd photopolymer layer 113 from -- the becoming lens array section 114 Radius of curvature and the 1st photopolymer layer 112 thickness -- protection-from-light layer 109 And optoelectric transducer 101 The vertical separation section 108 the irradiated light -- optoelectric transducer 101 It can condense thoroughly to inside.
[0009] and incident light -- the lens array section 114 when it is assumed that it receives and incidence is carried out vertically, it is shown in drawing 15 -- as -- an insulating layer 110, the phosphorus glass layer 111 (not shown), and resin layer 112 etc. -- from -- the thickness t1 of the becoming interlayer, and thickness t2 of the lens array section ** -- if a degree type (1) is satisfied when it carries out, a numerical aperture will become about 100 %.
t1 = {n1/(n1-n0)} and {(p2+t2 2) /2t2}-t2 ..... (1)
Here, it is n0 and n1. Air and the middle class's refractive index, and p are 1/2 of a horizontal pixel pitch, respectively.
[0010]
[Problem(s) to be Solved by the Invention] By the way, since laminating arrangement of a polish recon layer or an aluminum layer etc. which forms wiring is carried out on the light sensing portion in the solid state camera created by the semi-conductor production process at the multilayer, it is the distance t1 to the flattening layer upper part. About 4 micrometers is [minimum] necessary.
[0011] On the other hand, in the solid state camera, cutback-ization of the pixel aiming at high-resolution-izing is advanced, for example, pixel size has become 3.8-micrometer order in the solid state camera for 1/2 inch Hi-Vision. It sets to the solid state camera of such pixel size, and is the thickness t2 of the aforementioned (1) formula to a lens as n0 =1, n1 =1.5, t1 =4.0micrometer, and p= 3.8 / 2= 1.9 micrometers. It will be set to t2 =1.73micrometer if it asks.
[0012] In this case, a micro lens serves as a semi-sphere mostly so that thickness t2 =1.73micrometer of a lens and die-length (pixel pitch) 2p=3.8micrometer at the base of a lens may show. As for such a fabrication process of a semi-sphere micro lens, the process becomes difficult.
[0013] Moreover, brewster's-angle theta which causes total reflection is computed from a degree type (2).
sin theta=n 0 / n1 ..... (2)
In the case of n0 =1 and n1 =1.5, it becomes theta= 41.8 degrees. And total reflection of the light which inclines to plane of incidence more than this include angle, and advances is carried out. Therefore, when homogeneity light carries out incidence at right angles [upper part] to the lens section in the case of said semi-sphere lens, the rate which becomes invalid by total reflection is set to 1-{cos(90-theta)}2 =0.56.
[0014] That is, among the homogeneity light which carries out incidence to the lens section, 56% of light will not go into a light sensing portion by total reflection, and lowering of large photosensitivity will produce it. Furthermore, although incidence of the incident light by which total reflection was carried out by the lens periphery may be carried out to other pixels, in this case, it serves as generating of a cross talk and will

produce lowering of resolution and a response.
[0015] Thickness t2 of a lens An interlayer's thickness t1 It can be made thin by increasing. for example, the case where it is referred to as t1 =8micrometer -- the above-mentioned (1) formula -- t2 =0.71micrometer -- ** -- it becomes. In this case, it becomes the micro lens of a radii configuration, and vertical-incidence light passes a lens layer, without carrying out total reflection. Therefore, although a problem does not have the micro lens of such a radii configuration as a lens configuration, the problem on an optical path which is described below produces it. That is, when pixel size is reduced before and after 4.0 micrometers, light-receiving opening in a picture element part will become small below 2 micrometer**. And the polish recon for wiring in the opening circumference or multilayer aluminum wiring exists in all directions. In the production process of a micro lens on chip, if it doubles with the core of opening in a picture element part, and a micro lens and a gap arises, in the above-mentioned polish recon wiring or multilayer aluminum wiring, a part of incident light will receive an echo and absorption, and it will produce lowering of sensibility.
[0016] In a micro lens on chip, since the include angle of the incident light which passed the lens becomes near vertically so that the thickness of a lens layer is thin, compared with the case where a lens layer is thick, the echo by wiring and absorption will tend to take place, and will become. Moreover, since a gap (chromatic aberration) of the focal location by the difference of incident light wavelength becomes large so that the thickness of a lens layer is thin and a focal distance is long, setting out of the location (thickness of a flat layer) of the focus of a micro lens becomes difficult.
[0017] furthermore, the include angle of the incident light which carries out incidence to a micro lens by the f number (drawing) of a camera lens -- changing (the component of such a large incident angle increasing that an F value being small) -- a gap of an optical path when whenever [this incident angle] changes becomes so large (that the thickness of a lens is thin) so that a flattening layer is thick. Making thickness of a lens layer not much thin for the above reason arises, and it is not desirable. [of nonconformity] However, the factor to which a flattening layer becomes thick exists actually.
[0018] For example, in a veneer color solid state camera, light filters, such as red (R), green (G), and blue (B), are usually formed into the flattening layer under a micro lens. Moreover, the light sensing portion of a solid state camera is divided roughly, and is divided roughly into the assembling-die p-n diode currently used for CCD (Charge Coupled Device) image pick-up equipment, and the MOS mold diode currently used for CMD (Charge Modulation Device) image pick-up equipment. For MOS mold diode, especially blue glow is absorbed in part by the polycrystalline silicon which forms the electrode, and causes lowering of blue sensibility with it. On the other hand, there is utilization of the fluorescent substance thin film which cancels this fault and which changes blue glow into green - red light efficiently as law. Thus, when using a fluorescent substance thin film for a veneer color solid state camera, it is necessary to form a fluorescent substance thin film in the bottom of a light filter.
[0019] As mentioned above, in a veneer color solid state camera, when a fluorescent substance thin film or a light filter layer is formed, further, the distance to a semi-conductor front face will become long from the flattening layer upper part, and it becomes increasingly difficult to form a micro lens on chip for detailed pixels which fills the relation of the above-mentioned (1) formula in the flattening layer upper part.

[0020] The degree of freedom of a design of a micro lens is large, and exertion of sufficient micro-lens effectiveness is possible, and this invention aims at offering the solid state camera with which the light filter, the fluorescent substance thin film, etc. were simultaneously equipped with the micro lens on chip which can be formed, even if it was made in order to cancel the above-mentioned trouble in the solid state camera equipped with the conventional micro lens on chip, and a pixel is made detailed.
[0021]
[Means for Solving the Problem and its Function] In the solid state camera which has the light sensing portion which has arranged many pixels in which this invention contains photo diode in order to solve the above-mentioned trouble in the shape of two-dimensional, and an insulating layer including wiring formed on this light sensing portion At least, while preparing optical waveguide vertically to the light-receiving side of a light sensing portion in a part of insulating layer on said photo diode A micro lens on chip is formed in the upper part of this optical waveguide, and it constitutes so that the focus of this micro lens on chip may exist near [optical plane-of-incidence] said optical waveguide.
[0022] Thus, in the constituted solid state camera, it is condensed by the micro lens in the optical plane-of-incidence neighborhood of optical waveguide, and incident light is efficiently led to a light sensing portion by optical waveguide. Therefore, the limit in the insulating layer thickness which constitutes the flattening layer for micro lenses, or the thickness of a micro lens on a process is lost, and the design of a micro lens with a large degree of freedom of it is attained. Moreover, since an optical shelter does not exist in the insulating layer formed in the upper part of optical waveguide, the echo of light, absorption, etc. are not produced. Furthermore, a high sensitivity veneer color solid state camera becomes realizable by the detailed pixel by forming optical waveguide with a fluorescent material and preparing a light filter in the upper part.
[0023]
[Example] Next, an example is explained. Drawing 1 is drawing showing the production process which forms the 1st example of the solid state camera equipped with the micro lens on chip concerning this invention. Although this invention is applicable also to the thing using any of p-n junction diode and MOS mold photo diode as photo diode which constitutes the light sensing portion of a solid state camera, suppose that it is explained by being the thing using CMD which consists of MOS mold photo diode as a pixel in each example described below.
[0024] Setting to (A) of drawing 1 , 1 is n+. The source field of CMD which consists of a diffusion layer, and 2 are n+. The drain field which consists of a diffusion layer, and 3 are n. - It is the channel field which consists of an epitaxial layer. It is the gate electrode of CMD with which 4 consists of gate oxide and 5 consists of polycrystalline silicon, and MOS mold photo diode is formed with the channel field 3, gate oxide 4, and the gate electrode 5. 6 is an insulating layer which consists of an oxide film etc., and flattening of the front face 7 of an insulating layer 6 is carried out to Mr. light-receiving field 1 at rear-spring-supporter fitness after termination of a passivation film formation process and surface flat chemically-modified degree. Next, after forming the resist film 8 in the whole surface, the resist film 8 of the part which serves as opening 9 using the phot lithography method so that opening of the one field may be carried out at least of the MOS mold photo diode section is removed. then, reactive ion etching (RIE) -- using law, the

insulating layer 6 of the lower part of opening 9 is removed in different direction, and the hole 10 for optical waveguides is formed. In addition, in the above-mentioned etching process, the good etching gas system of the etch selectivity of an insulating layer 6 and the polycrystalline silicon which constitutes the gate electrode 5 is used.
[0025] after the process which forms the configuration shown in (A) of drawing 1 is completed, the resist film 8 is removed and, subsequently to (B) of drawing 1 , it is shown -- as -- the temperature below 500 ** -- low-temperature Low Pressure Chemical Vapor Deposition (LPCVD) which can form the good insulator layer and metal membrane of coat nature with the sufficient homogeneity of thickness -- law or Plasma CVD (PCVD) -- sequential formation of about 1000A the insulating thin film 11 and the metal thin film 12 of thickness is carried out by law etc. As an ingredient of the insulating thin film 11, a thing transparent to the light which was excellent in electric insulation, such as diacid-ized silicon (SiO2) and a silicon nitride (SiN), for example is good, and the ingredient which has high reflection factors, such as aluminum (aluminum), silver (Ag), and gold (Au), is suitable as an ingredient of the metal thin film 12.
[0026] In addition, the insulating thin film 11 is formed for avoiding the electric short circuit between wiring which consists of the metal thin film 12, a polycrystal silicon-gate electrode 5, or aluminum that exists in an insulating layer 6, although not illustrated. When process conditions without contact of wiring which consists of aluminum which chooses an etching process which leaves the thousands of A insulating layer 6 to the front face of the polycrystal silicon-gate electrode 5, and exists in an insulating layer 6, polycrystalline silicon, etc., and the metal thin film 12 can be chosen, in the etching process of the insulating layer 6 by the RIE method which followed, for example, was shown in (A) of drawing 1 , there is not necessarily no need for formation of the insulating thin film 11.
[0027] It changes into the condition that the metal thin film 12 was formed only in the side attachment wall of the hole 10 for optical waveguides, as [show / after formation of the above-mentioned metal thin film 12, / according to the RIE process which can remove only this metal thin film 12, / in (C) of drawing 1 / remove the metal thin film 12 in different direction, and].
[0028] then, it is shown in (D) of drawing 1 -- as -- the interior of the hole 10 for optical waveguides -- SiO2 etc. -- while embedding a transparent ingredient to the light and forming optical waveguide 10a, sequential formation of the flattening layer 13 for lenses and micro lens 14 which have parameter value which fills the relation of the aforementioned (1) formula is carried out using heat-softening-properties resin etc. Under the present circumstances, the focus of a micro lens 14 is designed so that it may exist near the front face 15 of optical waveguide 10a. Thereby, the solid state camera equipped with the micro lens on chip is obtained. In addition, in (D) of drawing 1 , 16 shows the incident light way.
[0029] In addition, in explanation of the above-mentioned production process, although explanation was given for the embedding process inside the hole 10 for optical waveguides, and the formation process of the flattening layer 13 for lenses as another process, in the formation process of the flattening layer 13, it is also possible to perform the process which performs embedding of the hole 10 for optical waveguides at once, and forms optical waveguide 10a.
[0030] It is possible to form the micro lens equipped with optical waveguide good in this

example, since an optical shelter moreover does not exist in the flattening layer 13 for micro lenses, it is efficient and condensing of incident light is attained at optical waveguide 10a, so that it may understand from the sectional view of (D) of drawing 1 . Moreover, since the condensed light is efficiently led to the photo diode section with the metal thin film 12 with a sufficient reflection factor, it is high sensitivity and the solid state camera of a low cross talk becomes realizable.

[0031] In addition, although the micro lens 14 showed what was formed in the front face of the flattening layer 13 in the above-mentioned example, of course, it is also possible to consider as the embedded lens configuration which embeds and forms the micro lens which consists of an ingredient which has a high refractive index into the flattening layer 13 from the flattening layer 13, and it is also possible to consider as the 2-story lens configuration which used together further the embedded lens and the micro lens formed in the front face.

[0032] Moreover, in the 1st example shown in drawing 1 , when forming the insulating thin film 11 by SiN (refractive index 2.0), improvement in the sensibility of the MOS mold photo diode which it is at the process termination event shown in (D) of drawing 1 , and is formed under the insulating thin film 11 of the multiplex cross protection of incident light if the thickness is made into 600 ** or nearly 1600A is attained.

[0033] Next, the 2nd example is explained. This example is equipped with the optical waveguide of a core clad (core clad) mold. Also in this example, the hole for optical waveguides is formed at the same process as the 1st example first shown in (A) of drawing 1 . However, as for the insulating layer 6, the refractive index is formed by about 1.5 insulating material. Next, as shown in (A) of drawing 2 , while applying the ingredient (refractive index 2.0 [about]) of TiO2 which has a high refractive-index value rather than the refractive index of an insulating layer 6 using a sol-gel method etc., embedding the interior of the hole for optical waveguides and forming optical waveguide 10a, the high refractive-index film 17 is formed in the whole surface. Subsequently, the resist film 18 is applied on the high refractive-index film 17, and surface flattening is performed. In addition, TiO2 Although it is a good insulating material, when the high refractive-index film 17 is formed with the ingredient which has electric conductivity, it is necessary to form the insulating thin film 11 beforehand like the 1st example shown in (B) of drawing 1 . Then, a RIE process performs etchback using etching conditions [as / whose selection ratios of the resist film 18 and the high refractive-index film 17 are 1]. Thereby, flattening of the front face of the high refractive-index film 17 is carried out good. Then, as shown in (B) of drawing 2 , the flattening layer 13 for lenses and a micro lens 14 are formed in right above [of optical waveguide 10a], and a solid state camera with a micro lens is completed.

[0034] In the 2nd example, since the ingredient which constitutes optical waveguide 10a has a high refractive index from the component of the insulating layer 6 which encloses optical waveguide 10a, the configuration of optical waveguide 10a fills the relation of a core clad, and the light condensed by the micro lens 14 is led to the photo diode section good. In addition, in the formation process of the high refractive-index film 17, after spreading of a high refractive-index ingredient, if surface surface smoothness is good, the etchback process of spreading of the resist film 18 and after that will become omissible. Furthermore, when the numerical relation of the aforementioned (1) formula is filled only with the thickness of the high refractive-index film 17, formation of the flattening layer

13 for lenses becomes unnecessary.
[0035] Furthermore, it is also possible to form a micro lens 14 in right above [of the high refractive-index film 17 shown in (A) of drawing 2 again depending on selection of an optical parameter] or right above [of the resist film 18], and to complete a solid state camera, and a micro-lens formation process is simplified substantially in this case. In addition, the etchback technique which carries out flattening of the front face of the high refractive-index film 17 explained by this example can apply the optical waveguide explained in the 1st example to the light also in the process which embeds a transparent ingredient and is formed.
[0036] Next, the 3rd example is explained using (A) - (D) of drawing 3 . In the 1st and 2nd examples, although what formed the hole for optical waveguides by etching was shown using the RIE method, as the conventional example also explained, as shown in (A) of those with about 4 micrometer, and drawing 1 , the problem that terminal point detection in case even the gate electrode 5 removes an insulating layer 6 is difficult has the thickness of an insulating layer 6. The 3rd example cancels this trouble. As a configuration, as shown in (A) of drawing 3 , they are right above [of the gate electrode 5], or hundreds of A SiO2. The film 20 is inserted, and in case it is removed in RIE processes, such as an SiN film, it has the description at the point in which the film 19 which performs intrinsic photoemission was formed.
[0037] According to this configuration, terminal point detection of etching of the insulating layer 6 for formation of the hole 10 for optical waveguides becomes possible effectively by detecting the intrinsic photoemission by the optical thin-film 19 from a proper at the time of formation of the hole 10 for optical waveguides by etching using the RIE method of an insulating layer 6. Since the process shown in (B) - (D) of drawing 3 after formation of the hole 10 for optical waveguides is the same as the 1st example shown in (B) - (D) of drawing 1 , the explanation is omitted here. However, in this example, the insulating thin film 11 shows what is not formed.
[0038] In addition, after clearance of the insulating layer 6 by etching which used the RIE method to the front face of this film 19 is completed, the optical thin-film 19 from a proper which consists of SiN etc. may be removed, or even if it makes it remain, it is not cared about. Moreover, as the 1st example also explained, the optical thin-film 19 from a proper consists of SiN, and when the thickness is about 600 ** or about 1600A, multiplex cross protection can attain the improvement effectiveness in sensibility of MOS mold photo diode.
[0039] Moreover, when removing the optical thin-film 19 from a proper thoroughly, the insulating thin film 11 may be made to intervene between an insulating layer 6 and the metal thin film 12 as well as the 1st example after termination of the etching process using the RIE method of an insulating layer 6 in the 3rd example. Moreover, to contact the metal thin film 12 with which wiring which exists in the interior of an insulating layer 6 is prepared in the side attachment wall of optical waveguide 10a even when the optical thin-film 19 from a proper remains even if, it is necessary to make the insulating thin film 11 intervene similarly too.
[0040] In addition, in drawing 3 which showed the 3rd example, even if the optical thin-film 19 from a proper which consists of SiN etc., of course, forms the optical thin-film 19 from a proper which consists of SiN etc. all over a light sensing portion, it is satisfactory [as formed only in the right above section of the gate electrode 5, it is illustrating, but]

in any way.
[0041] Next, the 4th example is explained. This example changes the configuration of optical waveguide with each above-mentioned example. In the 1st - the 3rd example, although what made the side attachment wall of optical waveguide vertical to the semi-conductor (silicon) front face, and made optical waveguide the shape of a cylindrical shape was shown, the 4th example is replaced with in the shape of [this] a cylindrical shape, and is characterized by the point which formed optical waveguide in the earthenware mortar configuration.
[0042] As shown in (A) of drawing 4 , in case an insulating layer 6 is etched by using the resist film 8 as a mask and the hole 10 for optical waveguides is specifically formed, it is the conditions by which a taper 21 is somewhat formed in a hole 10, and gaseous-phase RIE etching is carried out. The solid state camera equipped with optical waveguide 10a which has a earthenware mortar configuration according to the process same after that as the 1st example as shown in (B) of drawing 4 is obtained.
[0043] Since the area by the side of the optical plane of incidence of optical waveguide 10a spreads as an advantage by this example compared with the thing of the 1st - the 3rd example, it becomes possible to lead the incident light from a micro lens 14 to optical waveguide 10a more efficiently. Conversely, since opening may be small compared with optical plane of incidence, the tolerance over the doubling gap with the optical outgoing radiation side of optical waveguide 10a and the photo diode section becomes large, and the optical outgoing radiation side by the side of the photo diode of optical waveguide 10a becomes possible [also enlarging the margin to a doubling gap of a process]. In addition, concomitant use with the 1st - the 3rd example is possible for this 4th example.
[0044] Next, the 5th example is explained based on (A) - (D) of drawing 5 . In this 5th example, as shown in (A) of drawing 5 , after formation of an insulating layer 6, the antireflection film 22 which consists of Ti, TiN, etc. is formed in the upper part of an insulating layer 6 by continuing all over a light sensing portion, a resist pattern 8 is formed continuously, sequential clearance of the antireflection film 22 and the insulating layer 6 is selectively carried out by the RIE method, and the hole 10 for optical waveguides is formed. After termination of the process shown in (A) of drawing 5 , since it is the same as that of the 1st example shown in (B) of drawing 1 , and (C) almost as the micro-lens formation process shown in (D) of drawing 5 is shown in (B) of drawing 5 , and (C), the explanation is omitted.
[0045] In this 5th example, as shown in (D) of drawing 5 , since the stray light 23 which carries out incidence in addition to optical waveguide 10a is absorbed with an antireflection film 22, big effectiveness is in oppression of the alias of the flare etc. In addition, concomitant use with the configuration of the 1st - the 4th example is possible for the configuration of this 5th example.
[0046] Next, the 6th example is explained based on (A) - (D) of drawing 6 . This 6th example is related with the solid state camera with a micro lens which prepared the light filter for veneer color cameras. As first shown in (A) of drawing 6 , sequential formation of the insulating thin film 11 and the metal thin film 12 is carried out, and the metal thin film 12 is removed by the RIE method, and it considers as the condition that the metal thin film 12 was formed only in the side attachment wall of the hole 10 for optical waveguides so that the hole 10 for optical waveguides may be formed and may be shown subsequently to (B) of drawing 6 like the 5th example shown in (A) of drawing 5 .

Subsequently, as shown in (C) of drawing 6 , the organic or inorganic light filter material which has selection translucency, such as R, G, and B, is embedded to the interior of the hole 10 for optical waveguides, and the optical waveguide type light filter 24 is formed in it.
[0047] in addition, the corrosion prevention thin film 25 which consists of an insulating material of SiO2 grade before forming a light filter 24 by the formation process of a light filter 24, or its existence after forming the above-mentioned metal thin film 12 in the side attachment wall of the hole 10 for optical waveguides as shown in (C) of drawing 6 when there is a possibility that the metal thin film 12 may be corroded -- low temperature LPCVD -- what is necessary is just to form using law etc.
[0048] After forming the optical waveguide type light filter 24, as shown in (D) of drawing 6 , like the 1st example, the flattening layer 13 for lenses and a micro lens 14 are formed, and the solid state camera equipped with the light filter is obtained.
[0049] In this example, since the optical waveguide type light filter 24 is caudad formed from the bottom of the flattening layer 13 for lenses, i.e., near the focus of a micro lens 14, and it as shown in (D) of drawing 6 , the design of the thickness of the flattening layer 13 for micro lenses can be set up independently [a light filter 24], therefore the degree of freedom of the optical design of a micro lens can be made into size in spite of existence of a light filter. Moreover, since it is efficiently condensed by photo diode according to the optical waveguide effectiveness, implementation of the solid state camera excellent in color repeatability without high sensitivity and color mixture is possible for the light of each color selectively penetrated with the light filter 24. Moreover, concomitant use with the 1st, 3, 4, and 5 example is possible for this example.
[0050] Finally, the 7th example is explained based on (A) - (D) of drawing 7 . This 7th example is related with a light filter and the solid state camera with a micro lens which prepared the fluorescence ingredient layer. As first shown in (A) of drawing 7 , and (B), after forming the hole 10 for optical waveguides, sequential formation of the insulating thin film 11 and the metal thin film 12 is carried out like the 5th example shown in (A) of drawing 5 , and (B). Subsequently, as shown in (C) of drawing 7 , in the hole 10 for optical waveguides, fluorescent materials which change efficiently blue glow (wavelength: 400 - 450 nm) into green - red light, such as a coumarin, are embedded, and the optical waveguide type fluorescence ingredient layer 26 is formed. Then, as shown in (D) of drawing 7 , the flattening layer 13 for lenses included in it is formed, and, finally a micro lens 14 is created so that a light filter 27 may counter the fluorescence ingredient layer 26 and it may be located. In addition, the configuration which makes the thin film for protection which consists of an insulating material intervene between the fluorescence ingredient layer 26 and the metal thin film 12 is useful like the 6th example because of protection of the metal thin film 12.
[0051] Thus, in the constituted solid state camera with a micro lens, since the blue glow condensed by the micro lens 14 is efficiently changed into green - red light by the optical waveguide type fluorescence ingredient layer 26, high blue sensibility is obtained also in MOS mold photo diode. Furthermore, although the fluorescence by the fluorescence ingredient layer 26 is emitted in all the directions isotropic, since this fluorescence ingredient layer 26 forms optical waveguide, fluorescence is shut up in the fluorescence ingredient layer 26, therefore it can prevent effectively lowering of the color mixture in which fluorescence carries out incidence to other picture element parts and which it

produces, and the blue sensibility produced when fluorescence carries out fly off.
[0052] In addition, in the 7th example which in the case of the 3 plate color camera showed (D) of drawing 7 when using for a 3 plate color camera into a solid state camera, since a light filter is unnecessary, the fluorescence ingredient layer 26 does not need to form a light filter 27, although it is required. On the contrary, although the light filter 27 is required in the structure of the 7th example shown in (D) of drawing 7 since a fluorescence ingredient layer is unnecessary to apply to the solid state camera using the pixel of p-n junction photo diode structure, it is not necessary to form the fluorescence ingredient layer 26. In this case, the configuration which prepared the light filter as shown in the 6th example, of course is applicable.
[0053] Since the arrangement mode of the light filter shown in (D) of drawing 7 can be formed at the same process as the production process of the light filter used by the usual color sensor, the fabrication of a light filter of it is attained in the stable process.
[0054] Furthermore, the light filter 27 in this example also has the advantage that allowances arise enough in the formation process in consideration of the alignment of a light filter etc. compared with the case where a light filter needs to be formed all over the pixel in the case of the conventional color sensor that what is necessary is just to form near the optical plane of incidence of the optical waveguide type fluorescence ingredient layer 26. Furthermore, since parts other than optical waveguide type fluorescence ingredient layer 26 have composition covered with the antireflection film 22 as shown in (D) of drawing 7 , many advantages, such as color mixture prevention of a color sensor and reduction of the stray light, will arise. In addition, concomitant use with the 1st, 3, 4, and 5 example is possible also for this example.
[0055]
[Effect of the Invention] Since a micro lens is prepared in the upper part and the focus was made to exist near [optical plane-of-incidence] optical waveguide according to this invention as explained based on the example above while preparing optical waveguide in a part of insulating layer on photo diode, even if a pixel is made detailed, the degree of freedom of a design of a micro lens is large, and the solid state camera with a micro lens which enabled exertion of sufficient micro-lens effectiveness can be realized. Moreover, a high sensitivity veneer color solid state camera can be offered by the detailed pixel by forming optical waveguide with a fluorescent material and preparing a light filter.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the production process for explaining the configuration of the 1st example of the solid state camera concerning this invention.
[Drawing 2] It is drawing showing the production process for explaining the configuration of the 2nd example of this invention.
[Drawing 3] It is drawing showing the production process for explaining the configuration of the 3rd example of this invention.
[Drawing 4] It is drawing showing the production process for explaining the configuration of the 4th example of this invention.

[Drawing 5] It is drawing showing the production process for explaining the configuration of the 5th example of this invention.
[Drawing 6] It is drawing showing the production process for explaining the configuration of the 6th example of this invention.
[Drawing 7] It is drawing showing the production process for explaining the configuration of the 7th example of this invention.
[Drawing 8] It is the outline top view showing the example of a configuration of conventional INTARAIN transfer CCD image pick-up equipment.
[Drawing 9] It is the elements on larger scale of drawing 8 .
[Drawing 10] It is drawing showing the cross section which met the A-A' line of drawing 9 .
[Drawing 11] It is the sectional view showing the production process of the CCD solid state camera equipped with the conventional micro-lens array section.
[Drawing 12] It is the top view showing the production process following the production process shown in drawing 11.
[Drawing 13] It is drawing showing the cross section of drawing 12.
[Drawing 14] It is drawing showing the cross section of a CCD solid state camera in which the micro-lens array section was formed.
[Drawing 15] It is an explanatory view for explaining the relation between the thickness of the lens array section and an interlayer's thickness, and a numerical aperture.
[Description of Notations]
1 CMD Source Field
2 CMD Drain Field
3 Channel Field
4 Gate Oxide
5 Gate Electrode
6 Insulating Layer
7 Insulating-Layer Front Face
8 Resist Film
9 Opening
10 Hole for Optical Waveguides
10a Optical waveguide
11 Insulating Thin Film
12 Metal Thin Film
13 Flattening Layer for Lenses
14 Micro Lens
15 Optical Waveguide Front Face
16 Incident Light Way
17 High Refractive-Index Film
18 Resist Film
19 Optical Thin-film from Proper
20 SiO2 Film
21 Taper
22 Antireflection Film
23 Stray Light
24 Optical Waveguide Type Light Filter

25 Corrosion Prevention Thin Film
26 Optical Waveguide Type Fluorescence Ingredient Layer
27 Light Filter